Answer any FOUR questions out of SIX. All questions carry equal marks
Time: TWO hours

Answer any Section A questions you attempt in Answer Book A
Answer any Section B questions you attempt in Answer Book B

The marks given in brackets are indicative of the weight given to each part of the question.
Only non-programmable calculators are allowed in this examination.

Section A

Answer Section A questions in Answer Book A

A1. This part of the question is about broadband Internet access.
   a) A common method for providing broadband Internet access over existing telephone lines is Asymmetric Digital Subscriber Line (ADSL).
      i. Why is it called asymmetric? (4 marks)
      ii. Briefly describe how ADSL is able to transmit both data and telephone calls over the same twisted pair cable connecting a house to a local exchange, without the two signals interfering with each other. (8 marks)

   This part of the question is about local area networks and the technology usually known as WiFi (IEEE802.11)
   b) Briefly explain the difference between the terms infrastructure and ad-hoc when used to describe the operational modes of a WiFi. (8 marks)
   c) In what circumstances is it appropriate to use ad-hoc mode, and why? (5 marks)

A2. This question is about virtual circuits and the Transmission Control Protocol (TCP) and User Datagram Protocol (UDP).
   a) Define the concept of virtual circuit. (4 marks)
   b) Explain the three-way handshake process used by TCP to establish a virtual circuit. (9 marks)
   c) Explain how the TCP protocol would be able to detect errors and data loss, and how it would ensure that the lost data is re-transmitted, whilst transmitting data over a TCP virtual circuit. (8 marks)
   d) In contrast to TCP, UDP is described as a connectionless protocol. Briefly explain how data is transmitted between two computers using the UDP protocol. (4 marks)
A3. This question is about providing global network services.

a) Telecommunication companies (Telcos) that provide global network services, define the services they offer to customers in a Service Level Agreement (SLA). Explain the purpose of an SLA and give examples of what it might contain. (7 Marks)

b) Companies that have offices in several countries around the globe need to create a private corporate network that is able to connect these sites together and transport traffic of different types between them. An increasingly popular way of providing such a network is to use Multiprotocol Label Switching (MPLS) data services. Briefly explain how MPLS works and how it is able to support different traffic types. (12 marks)

c) An alternative to MPLS might be to consider using the Internet. What are the main disadvantages of the Internet that mean it would offer a worse solution than MPLS? (6 marks)

Section B

Answer Section B questions in Answer Book B

B4. This question is about routing tables and the way routers maintain them.

a) Describe three different sources a router can use to put/maintain the information contained in the routing table. (6 marks)

b) Indicate three main differences between link-state and distance-vector routing protocols. (6 marks)

c) Indicate the type of routing protocol (distance-vector or link-state) and the metric used by each of the following protocols:
   i. RIPv1
   ii. EIGRP
   iii. OSPF (2 marks each)

d) Briefly describe the link-state protocol known as OSPF and explain how it copes with routing inside a large and complex autonomous system. (7 marks)

B5. This question concerns the Quality of Service (QoS) provided by networks that use the Internet Protocol (IP).

a) The Internet is often described as being a “best effort network”. Briefly explain what is meant by the term “best effort network”. (4 marks).

b) Identify, and briefly describe, three QoS parameters that are often measured to characterise the behaviour of a network or network connection. (6 marks)

c) Discuss the quality of service requirements of a Voice-over-IP (VoIP) application and how they differ from those of a video-based application. (8 marks)

d) Briefly describe the RSVP approach to controlling QoS. (7 marks)
B6. This question is about error detection and correction including Hamming codes and cyclic redundancy checks.

a) Explain the difference between single-bit errors and burst errors in data transmission. (4 marks)

b) What is meant by a parity check? What sort of errors can parity check detect? (4 marks)

c) Explain the terms *transverse parity check* and *longitudinal parity check*. How can they be combined to provide an error correction capability? (6 marks)

d) In coding theory, what is meant by:
   i. the Hamming distance between two bit strings of equal length? (3 marks)
   ii. the minimum Hamming distance of a code? (3 marks)

e) How does the minimum Hamming distance of a code relate to its error detection and correction capability? (5 marks)